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(54) Leak detecting of vacuum sealed packages

(57) In the vacuum-packaging of foodstuffs in sealed thermoplastics envelopes, it is essential to ensure that no leaks occur and that the seal of the foodstuff within the package is satisfactory. Two types of leaks are known, that in which substantially no effective seal was created and thus a substantial volume of air is within the package and those in which pin holes, are formed which form "leaker" packages in which small quantities of air gradually enter into the package.

This invention determines faulty sealed thermoplastics vacuum sealed packages by reducing pressure around the package and thus, allowing the package to expand due to the expansion of the remaining air within the package. The volumetric expansion of the package is determined by sensor(s) including electrical ones such as a condenser. Alternatively, and additionally, packages which have not been sealed at all will be more flexible than those which have been sealed and these may be determined by a bending test, a central part of the package being forced in one direction, relative to the opposite end parts.

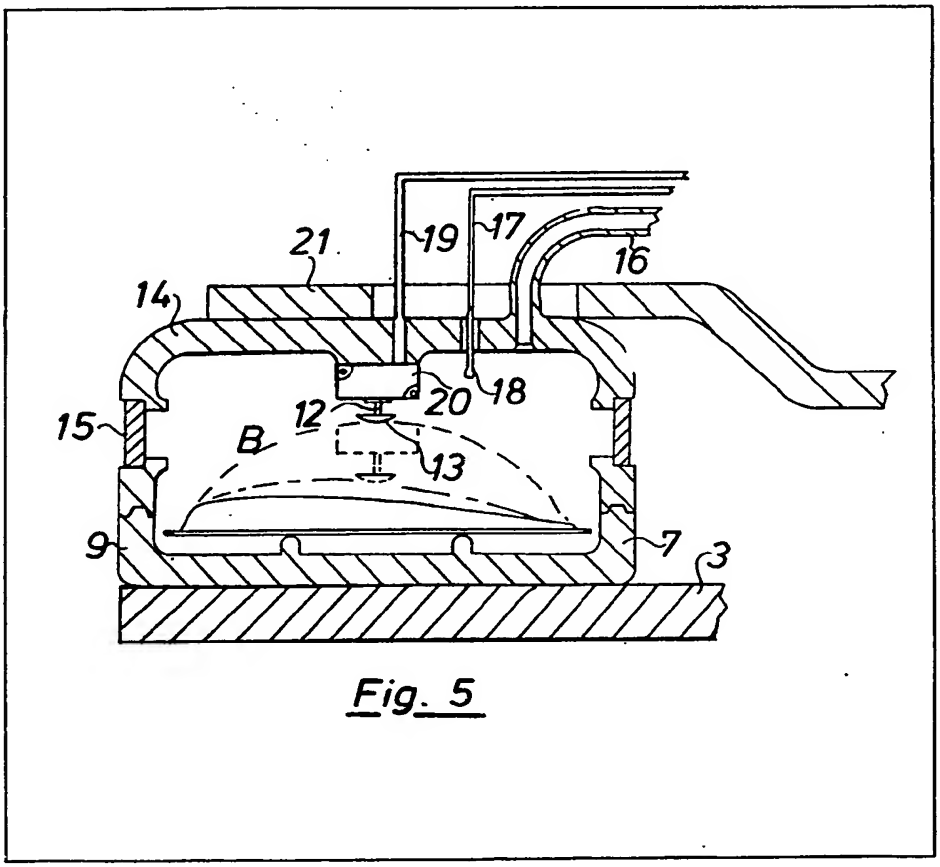

Fig. 5

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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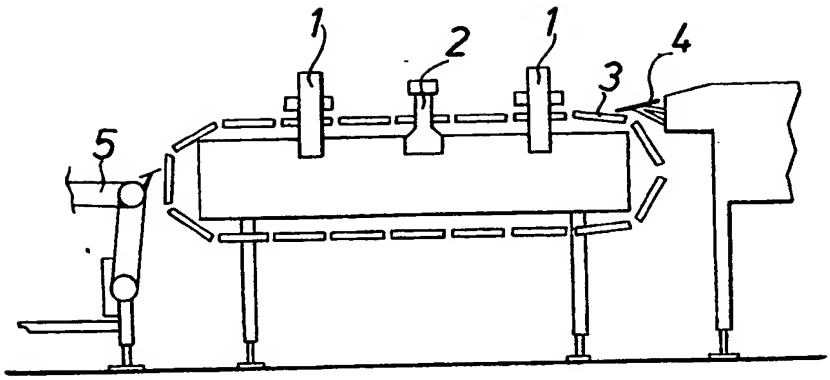

Fig. 1

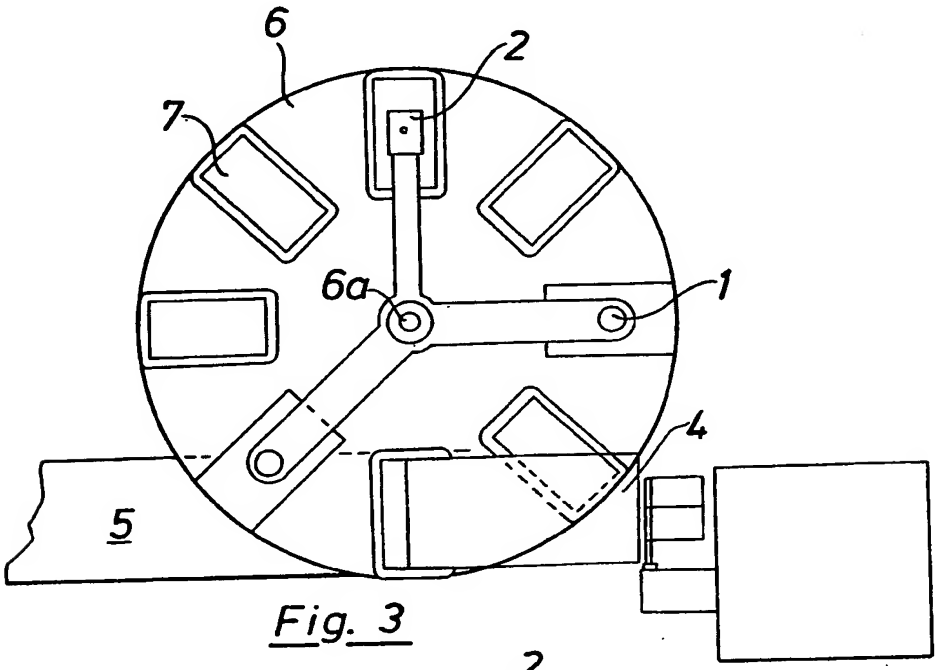

Fig. 3

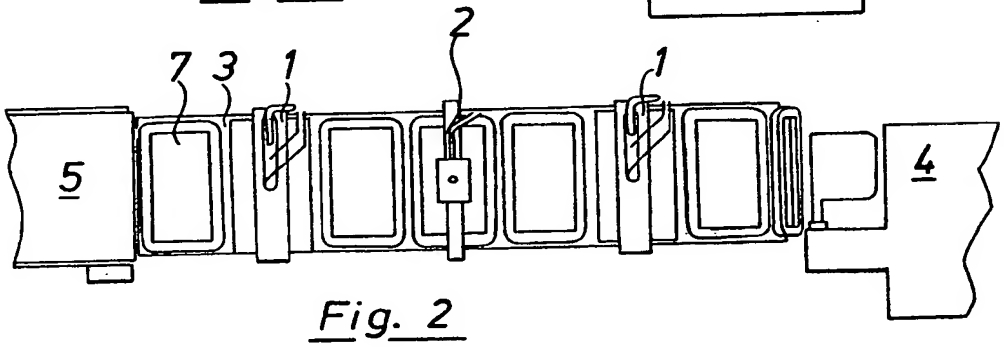

Fig. 2

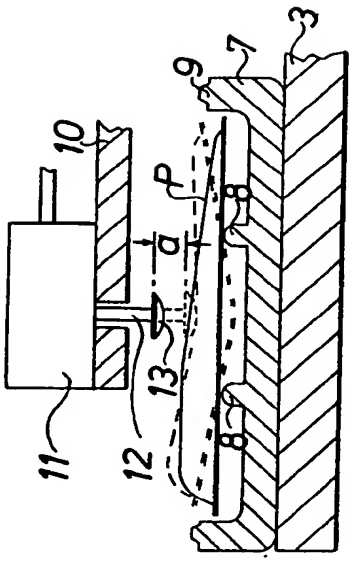

Fig. 4

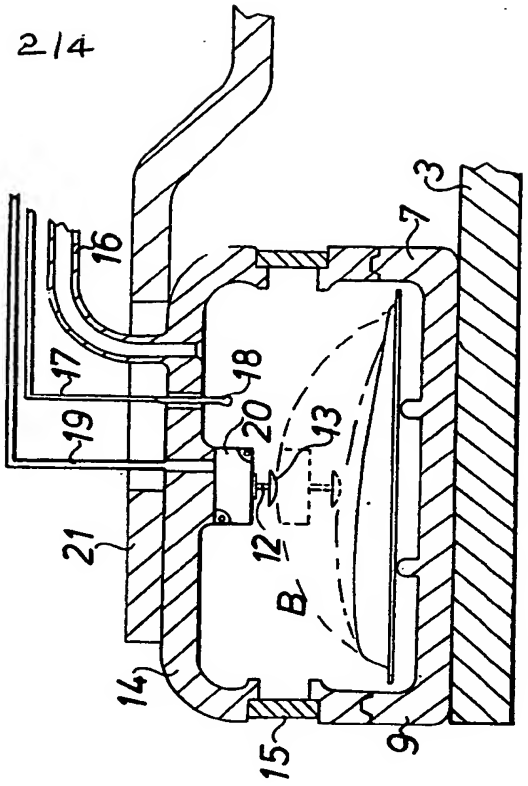

Fig. 5

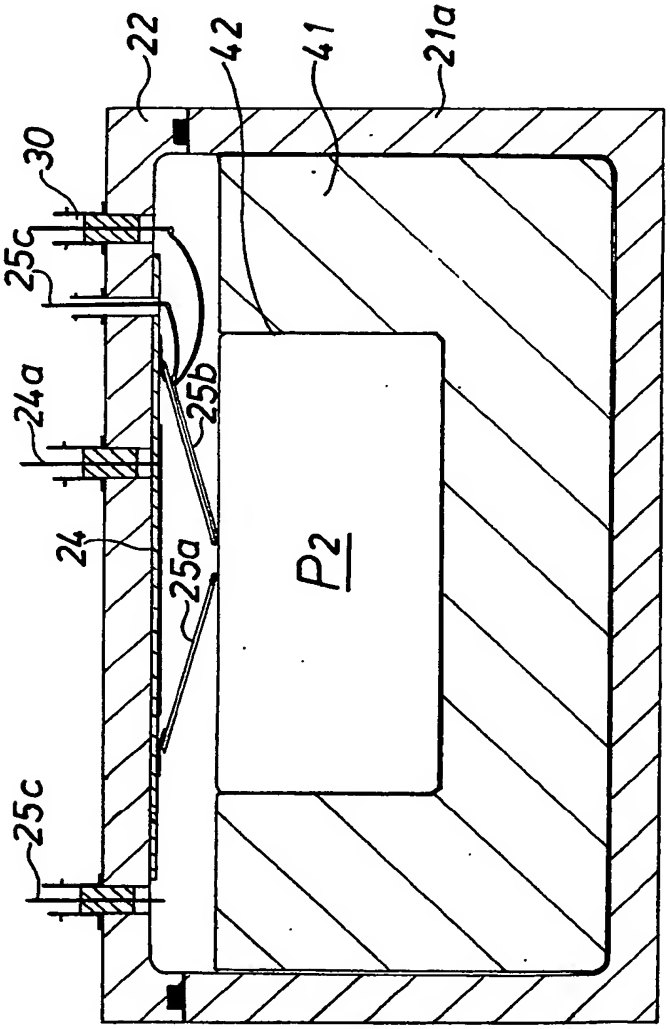

Fig. 11

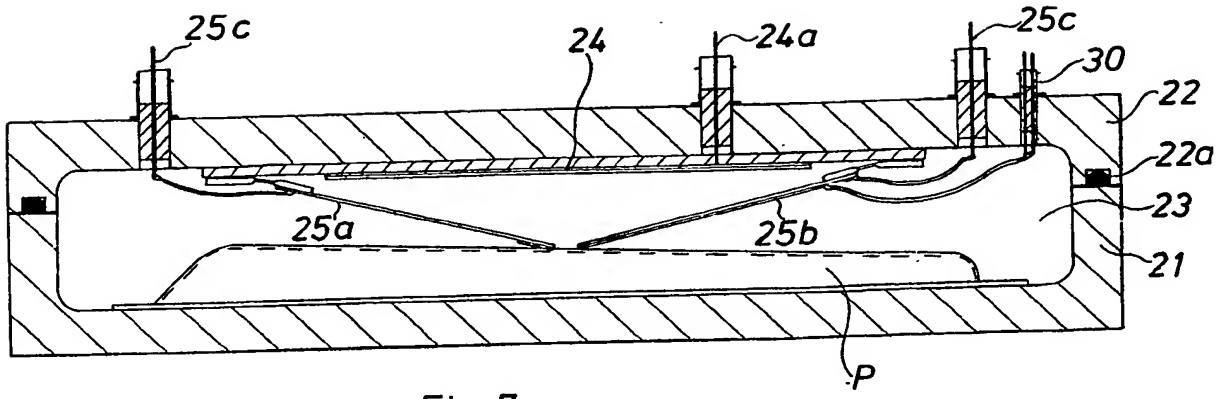

Fig. 7

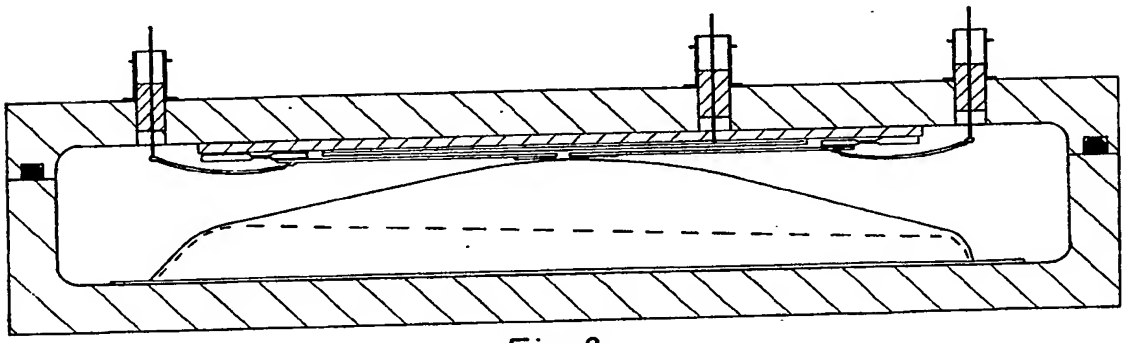

Fig. 8

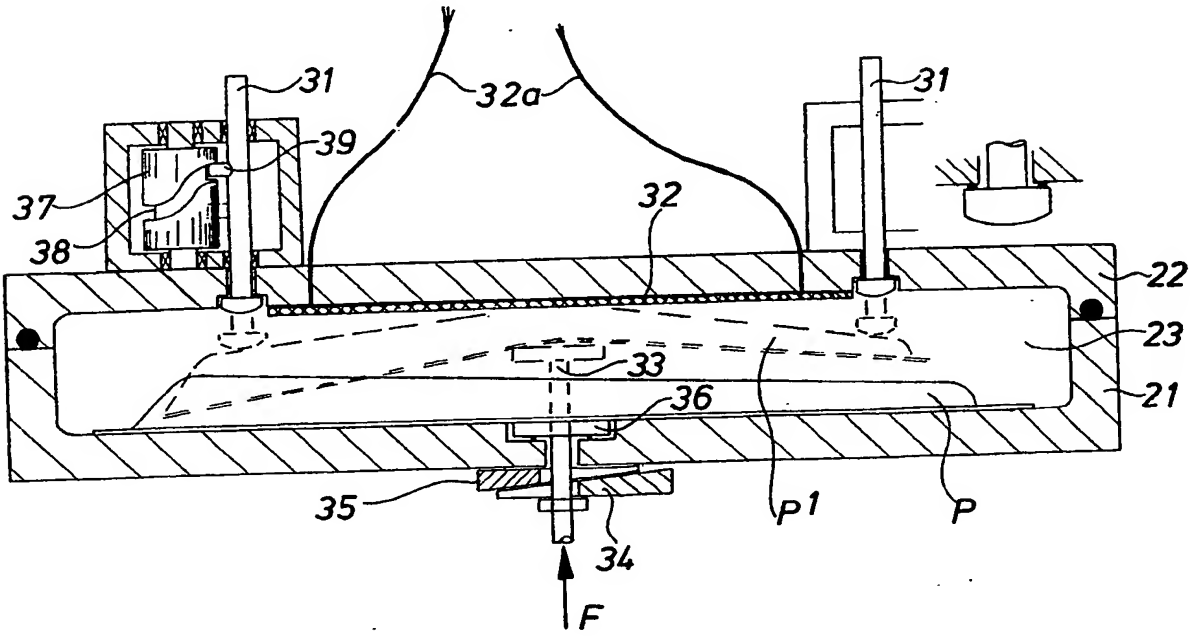

Fig. 9

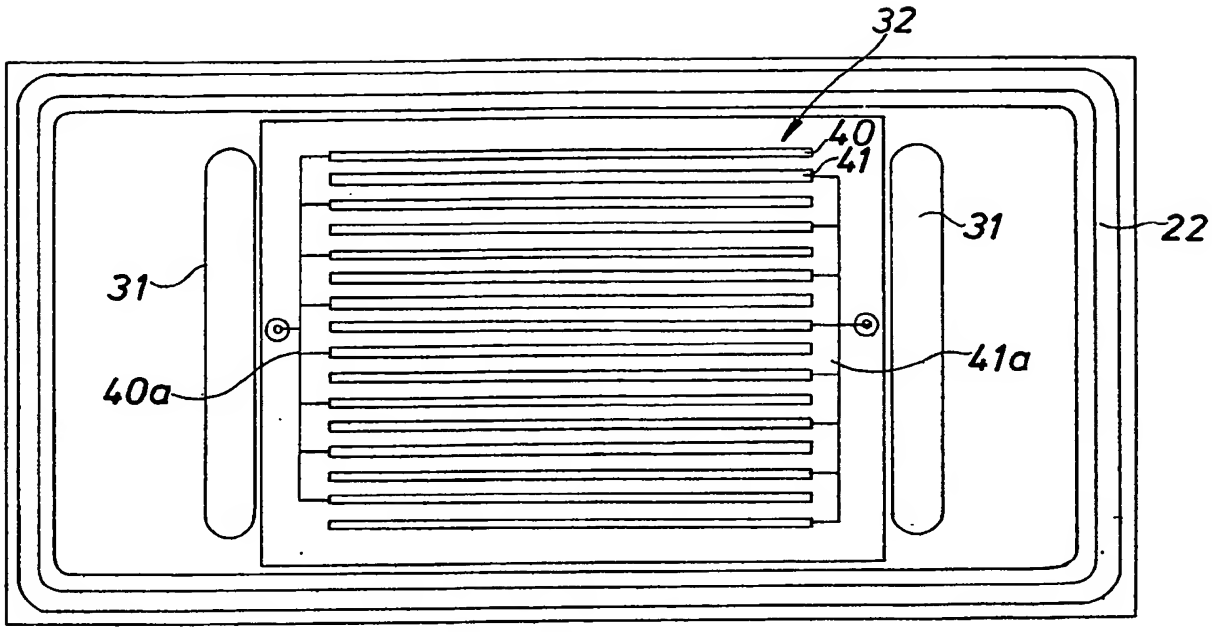

Fig. 10

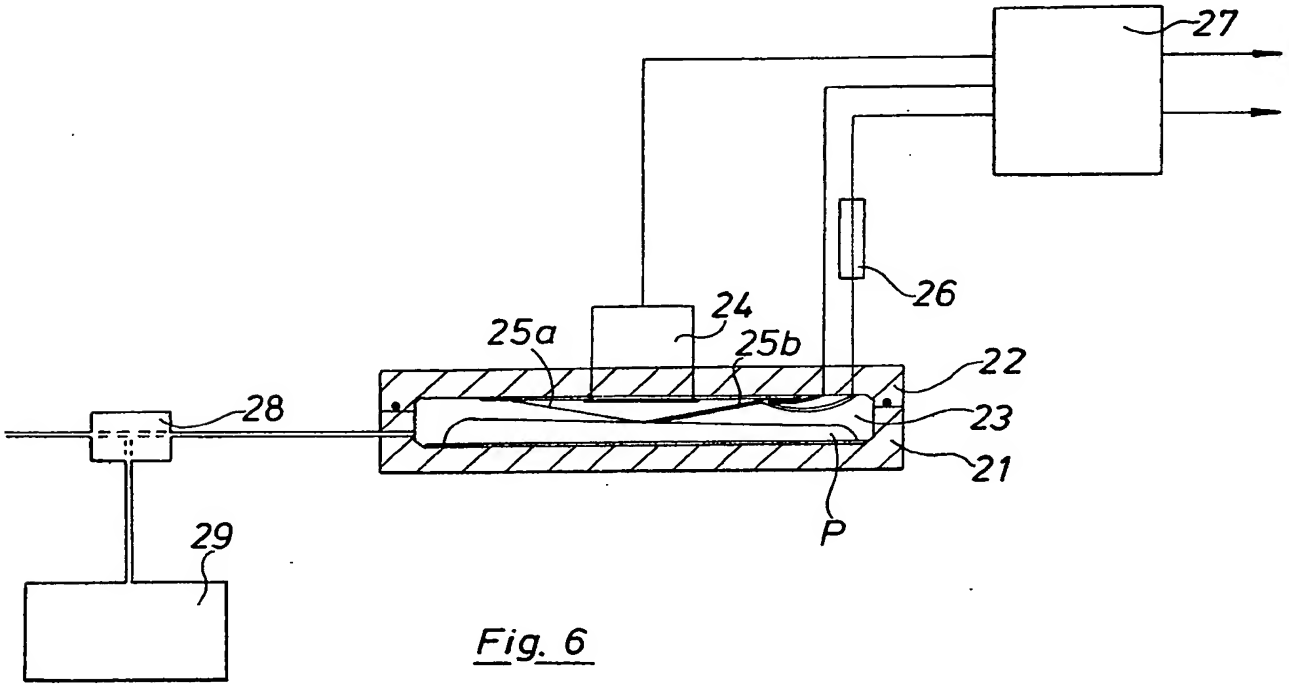

Fig. 6

SPECIFICATION
A leak detector

This invention relates to apparatus and methods for detecting leaks in hermetically sealed packets especially of sealed foodstuffs.

It is known to packet foodstuffs of various kinds within an envelope of thermo-plastics material from which the air has been evacuated and which envelope is then sealed so that the foodstuff is contained within a substantially air-free atmosphere, and maintained at such within the envelope.

It will be appreciated that a foodstuff so packed will retain its freshness and will not deteriorate for a considerable period of time even if maintained at ambient temperature but such a packed foodstuff if maintained at refigerated temperature will retain its freshness and suitability for human consumption for a considerable period of time, certainly much longer than if it were packed in an air atmosphere.

The packaging of foodstuffs of this kind may consist in inserting the foodstuff into an envelope formed by folding over a single sheet of thermo-plastics material and then heat sealing the material against itself on at least two sides, removing the air from the interior of the envelope and sealing on fourth side.

In an alternative construction two sheets of thermo-plastics material are used, one is used to form a pocket into which the foodstuff is laid and then the pocket is closed by a second sheet and which is sealed around the sides of the first sheet after substantially all the air has been removed. The layers of thermo-plastics material are often laminar in form with an outer surface of one material which is relatively hard-wearing with an inner laminar surface which is heat meltable at a lower temperature than the outer material, and which enables the sealing together of the two inner surfaces to take place at a temperature which does not adversely affect the foodstuff being packed.

It will be appreciated that the success of such packed foodstuffs is that no air is allowed to enter the package. It is a factor that some of the packed foodstuffs are known as "leakers", that is to say that the seal or the thermo-plastics material is of such a nature that air is allowed to leak into the interior of the envelope and thus allow foodstuff to commence deterioration.

The "leakers" occur in several different ways among which is the failure to make a secure joint when closing the envelope. Another one is the thermo-plastics material may have pin holes in it which are caused during the formation of the thermo-plastics material, or alternatively may have weaknesses which when the thermo-plastics material is forced on the foodstuffs during the packaging (i.e. when the air has been withdrawn from the interior of the package and atmospheric pressure is then applied to the exterior surface). When the thermo-plastics material is forced on to the surface of the foodstuff a pin hole leak in the thermo-plastics material may arise. In another instance of an unsatisfactorily sealed packet an insufficient volume of the air within the packet is withdrawn before the packet is sealed. Thus a volume of air is left within an otherwise correctly sealed packets and such packets are also referred to as "leakers".

In the mass production packaging of such foodstuffs, it is necessary for such "leakers" to be detected and while the "leaker" in which there has been substantially no sealing may be detected quite easily, those in which pin holes have been formed are less easy to detect.

It is an object of the present invention to provide apparatus for detecting the two different types of "leakers" i.e. those in which pin holes are formed in which air will gradually enter into the envelope, and those in which the air has already entered into the envelope due to a substantial hole or failure of the final sealing process of the thermo-plastics material to take effect. Another object of the present invention is to provide an apparatus for the determination of a correctly sealed package i.e. one in which the air has been removed and the seal is good so that the contents thereof may be expected to remain in a consumable and satisfactory condition for a predetermined period of time, which will be substantially longer than those packages which are "leakers".

The invention in particular therefore provides a method of testing for a leaking package of the kind referred to which comprises supporting the package at two spaced apart points, applying a predetermined pressure to the package between the support points and ascertaining the deflection of the package. If the package is correctly sealed then it will be relatively stiff and by applying a predetermined pressure to the supported package the deflection of the centre of the package will be relatively small. On the other hand, if air has already entered into the package and the contact between the foodstuff and the interior of the thermo-plastics material is such that the thermo-plastics material may slide freely over the package, then the deflection which will occur in the centre between the support joints will be much greater.

The invention also is concerned with a method of testing for a leaking package of the kind referred to which comprises supporting a package in a predetermined manner within a chamber evacuating air from the chamber and determining the volumetric expansion of the package. In this arrangement the invention provides for the testing for a pin hole leaking package in which air is allowed to enter into the package relatively slowly. In such a package there will be already a volume of air and by inserting the package into a chamber, rapidly removing air from within that chamber, the air within the package will be forced to expand due to the reduction of pressure on the exterior of the package, and since the pin hole is relatively small the air will not be able to escape through that pin hole sufficiently quickly and thus the

volume of the package itself will expand. By placing sensors adjacent to the surface of the package it is possible to determine the expansion of that package and so determine that the package is a "leaker". As the air pressure is reduced in the chamber in which the package has been placed so the air within the package will expand and the volumetric dimensions of the package will increase. It has been found that under some circumstances it is possible to detect a correctly sealed pack from a "leaker" and also from one which has been not sealed at all by determining the unit volume expansion of the pack. In alternative arrangement the air pressure is reduced so that the pack is increased to a certain volumetric expansion factor and the air pressure is then slightly increased, thus, forcing the volumetric expansion of the pack to reduce. It has been found satisfactory to determine the pressure at which the volumetric expansion of the pack reaches a predetermined factor. With this arrangement it will be appreciated that if more than a predetermined volume of air is already in the pack, such as would occur in the case of a "leaker", then it will require an increase of the pressure within the chamber in order to force the pack down to a predetermined volumetric size and thus, parameters can be set for the volumetric expansion of the pack at a predetermined pressure and if that pressure is above that predetermined value then the pack can be designated a "leaker". Equally with such a method of testing if the pack is a completely slit "leaker" so that there is substantially no air within the pack, then as the air pressure in the chamber is reduced, there will be no volumetric expansion of the pack until such time as the gases within the foodstuff, or within the pack itself, expand by boiling at the reduced pressure and force the cover forming the pack to rise. Thus, there will then be a detectable volumetric expansion of the pack. This may occur at a pressure lower than that at which one would normally detect either a good pack or a "leaker". It will however be appreciated that at the moment the pressure is increased in the chamber to that which is above the pressure at which the gases within the foodstuff are boiling the pack will then collapse and thus, the volumetric expansion of such a pack will reduce much more rapidly at a lower pressure than with a normal pack. Thus, by firstly reducing the pressure and causing maximum volumetric expansion and then allowing the pressure to rise within the chamber and determining the reduction in the volumetric expansion from the maximum, it is possible to set parameters at which, if that volumetric expansion is reached at a substantially lower pressure than normal it will be a slit pack, if it reaches the predetermined volume at a higher pressure it will be a good pack and if it reaches the predetermined volume at an even higher pressure it will be a "leaker" pack.

In order that the invention may be more readily understood, reference is now made to the accompanying drawings in which:—

Figure 1 is a side view showing schematically one arrangement according to the present invention;

Figure 2 is a plan view of Figure 1;

Figure 3 is a plan view showing schematically an alternative arrangement according to the present invention;

Figure 4 is a cross-sectional view of detail of the apparatus for determining one type of leaking package;

Figure 5 is a cross-sectional view showing in detail apparatus for determining another type of leaking package.

Figure 6 shows schematically an alternative arrangement for determining incorrectly sealed packs according to the present invention;

Figures 7 and 8 are cross-sectional views showing the method of determining the volumetric expansion of the pack;

Figure 9 is an alternative method of determining an incorrectly sealed pack according to the present invention;

Figure 10 is a detailed view of the condenser component used with the construction of Figure 9; and

Figure 11 is a cross-section view of an alternative chamber for use with the determination of "leakers" according to the present invention.

In Figure 1 there is shown a conveyor 3 which received packed foodstuffs from an in-by conveyor 4 and there is also shown an out-by conveyor 5 which receives the tested foodstuff packages from the conveyor 3 and which then conveys the packed and tested foodstuff packages to a packing station. The foodstuffs having been received on to conveyor 3 are fed firstly to a station 1 at which they are subjected to a vacuum head as hereinafter described for determination of pin hole leaks. They are then fed to a station 2 which determines a substantially large hole in such a foodstuff package and then to a third station 1 which is identical to the first station 1 for a repeat of the testing of the pin hole package.

In Figure 2 which is a plan view of Figure 1, it will be appreciated that the packages fed from the in-by conveyor 4 fall into receptacles 7 located on the surface of the conveyor 3.

In Figures 1 and 2 it will be appreciated that the conveyor 3 has to index the packages one at a time to the testing stations 1 and 2 and there is thus a pause while the package on the conveyor 3 is tested for leaking and then the test station is removed as hereinafter described and the package indexed along the conveyor.

In Figure 2 a rotating table 6 is provided which receives packed foodstuffs from an in-by conveyor 4 at one level and deposits the packages on an out-by conveyor 5 at a lower level and between the in-by conveyor 4 and the out-by conveyor 5 the packages are rotated within the pocket 7 to testing stations 1 and 2 which may be rotated about a central axis 6*a* supporting arms for the testing heads 1 and 2. The arm is able to rotate as the table rotates with the foodstuff packages in

the pockets 7 and thus a continuous testing process according to Figure 3 is provided.

The testing heads are illustrated with reference to Figures 4 and 5, and Figure 4 is for testing those packages which already contain a substantial quantity of air due to a substantially large hole being formed in the package. The pocket 7 is provided with a pair of upstanding ribs 8 and the packet illustrated diagrammatically as P in Figure 4 is supported on the ribs 8. Above the pocket 7 is an arm 10 which carries a sensor mechanism 11 which is operated by a shaft 12 having a mushroom head 13. The arm 10 is lowered until the mushroom head 13 is at a predetermined height above the package P and then the shaft 12 is extended by the mechanism 11. The shaft 12 is extended until such time as the mushroom head 13 contacts the package P thereafter a predetermined pressure is applied to the shaft 12. Desirably this may be in the order of 250 grams. At that pressure, a package which is a non-leaker and correctly sealed will have only a minimal deflection, perhaps in the order of 1/8 inch. If however, the package is a substantial leaker then the thermo-plastics material enclosing the foodstuff is able to slide freely over the foodstuff and a substantially greater deflection of the shaft 12 is determined by the sensor 11 and an appropriate indication may be given on a consol or desirably the foodstuff packet so marked so that it is not deposited on the out-by conveyor 5 but by a suitable flap or like mechanism is deposited into a box for reject packages, which may then be broken down and resealed or dealt with as desired.

In Figure 5 a vacuum head is provided which enables the packages having pinhole leakages to be determined. The package P is located on the upstanding ribs 8 of the pocket 7 and a vacuum head 14 is arranged to fit on to the upstanding peripheral ribs 9 of the pocket 7. A window 15 of glass or other material is provided which enables viewing of the interior of the chamber to take place. The head 14 is lowered from the arm 21 and in conjunction with the pocket 7 defines a chamber 14*a*. Within the chamber 14*a* is a vacuum exhaust pipe 16, a sensor device 18 connecting to a sensor feed 17 and a linear extension sensor 20 connected by a sensor lead 19 to an appropriate consol. The sensor 20 is provided with a similar mushroom head 13 mounted on the end of a shaft 12. After the package has been placed on to the upstanding ribs 8 the air within the chamber 14*a* is evacuated from a suitable source of negative pressure through the pipe 16 and if the package is a non-leaker then the pressure on the outside of the package will equalise substantially the pressure on the interior of the package and the package will be at rest and will not move on the upstanding ribs 8. However, if the package is a leaker and a small quantity of air has entered into the package through a small pin hole, then on reduction of the pressure on the exterior of the package the air within the package will expand and the package will bow as indicated at B in dotted lines in Figure 5 until such time as the package contacts the mushroom head 13, moves the shaft 12 thus operating the sensor 20. Through the connection 19 to a consol or other warning device a notification is given that the package being tested is a "leaker" and it may then be subject to a reject mechanism so as not to be fed to the packaging station.

Figures 6, 7 and 8 illustrate an alternative arrangement for determining the volumetric expansion of the package P. A chamber 23 is defined by a lower member 21 on which an upper member 22 may be pneumatically sealed. A vacuum pump and reservoir 29 are controlled by a valve 28 in order to control the air pressure within the chamber 23. An electrical condenser is formed by a pair of hinged leaves 25*a* and 25*b* which are electrically interconnected and pivotted to the underside of member 22 and which form together with a plate 24 an electrical condenser circuit, as seen more particularly in Figures 7 and 8. The leaves 25*a* and 25*b* are connected to outlet terminals 25*c* extending through the member 22 and the plate 24 secured to the underside of member 22 is electrically connected to an outlet terminal 24*a*. In order that true comparison of the tests on respect of packages takes place, a temperature sensor 30 is provided in the member 22, in order to determine the temperature within the chamber 23. As the air pressure within the chamber 23 is reduced, the package P will expand and as it expands the upper surface will contact the leaves 25*a* and 25*b* and force them upwardly as seen in Figure 8, thus bringing them closer to the sheet 24 and thus, increasing the capacitance between leaves 25*a* and 25*b* and sheet 24. This increase in capacitance can be read on appropriate electrical instruments indicated generally at 27 in Figure 6. The electrodes 24, 25*a* and 25*b* are conveniently with a waterproof plastics film and the end edges of the leaves 25*a* and 25*b* provided with a P.T.F.E. coating to assist their movement over the upper surface of the expanding pack P.

The apparatus may be used in one of two ways, either that which has been described previously, namely as the air pressure is reduced within chamber 23, so the volumetric expansion of the package P is determined by the increase in the capacitance, or it may be determined in the following alternative way.

Firstly, the air pressure is reduced until the package has expanded to a predetermined volumetric expansion factor, determined by the capacitance read-out instruments. The pressure is then increased in the chamber 23 which allows the volumetric expansion of the factor of the packet P to be reduced. The pressure then is noted at which the volumetric expansion of the package is at a predetermined figure. These two figures, that is, the pressure and the volumetric expansion factor, are then regarded as the figures for a correctly sealed packet. The figures are determined by trial and error from known correctly

sealed packages. If then a "leaker" is placed in the chamber 23 it will require a higher pressure in order to obtain the predetermined volumetric expansion factor of the package due to the presence of more air within that package. If the package is a slit one, that is to say, substantially no seal has been formed or a large hole has been found, then in general the volumetric expansion factor of the package will be lower at the predetermined pressure. In such a package the volumetric expansion, that is to say, the lifting of the package material of the contents of the package will occur only when the pressure within the chamber 23 is reduced to an extent at which the gases within the contents of the package begin to boil. The pressure may be below that at which the predetermined volumetric expansion factor for a correctly sealed package would occur, so that a first indication that it is a wrongly sealed package will occur at that stage. Then as the pressure is increased the volumetric expansion factor of the package will rapidly reduce until it is almost the same as when the package was placed in the chamber and this will occur at a much lower pressure than for a correctly sealed package. Thus, by this method both the pin hole "leaker" package will be determined as well as the correctly sealed package, as well as the non-sealed package or slit package. Alternative methods of detecting the expansion of the package are within the scope of this invention. The hinged leaves could be connected to independent position transducers of capacitance, inductive or resistive type. The hinged leaves or leaf could also be detected by optical means such as a light source and photocell. The position of the package surface as it expands could be detected without the need for a hinged leaf. If the film of the package were opaque the photocell and light source could detect the film surface direct. Alternative methods include finding the position of the film from the surface scatter of an optical beam inclined at a small angle to the prependicular to the surface.

In Figure 9 an alternative method of determining the slit package is illustrated to that which is illustrated with reference to Figures 4 and 5 but the principle is similar. The package is placed within the chamber 23 and a ram 33 in the centre of the package is raised by a force F. A pair of movable wedges 34 and 35 provide an adequate locking mechanism to prevent movement of the ram 33 except when the wedge 34 has been slid to one side and a seal 36 may be provided so that the chamber 33 may also be used for the reduced pressure testing as previously described. The ram 33 thus forces the centre of the package upwards and a pair of rams 31 are moved downwards. The rams 31 have a lug 35 formed on their sides which lug slides in a tract 33 formed in a rotatable drum 37. By appropriate rotation of the drum 37, the rams 31 may be raised into the member 22 or lowered down to force the edges of the package downwards against the upward pressure of the ram 33. For a correctly sealed package the ram 33 will be unable to force the centre of the pack up to the condenser board 32 described hereinafter but for a "leaker" pack which is slit and has substantially no sealing effect, the pack will be flexible and the centre of the pack will be forced upwards onto the condenser board 32 as indicated in dotted outlines at P1 in Figure 9. Electrically leads 32*a* lead from the condenser board 32 and the moment the centre of the pack P1 contacts the board 32 an indication will be given on an electrical instrument connected to the lead 32.

The condenser board 32 is illustrated in Figure 10, the board consists of a plurality of parallel electrically conducting rods 40 and 41 forming two series; all the rods 40 are connected in parallel with each other and lead to an electrical connection 40*a*, while all the rods 41 lead to a similar common electrical connection 41*a*. The rams 31 are located either side of the condenser board 32 as seen in the plan view of Figure 10. It will be appreciated that the capacitance across the leads 32*a* will be increased the moment any portion of the package contacts across any of the rods 40 and 41. The greater the surface area of the package which contacts the rods 40 and 41, the greater will be the increase in the capacitance across the leads 32*a*.

The drawings previously illustrated are suitable for use with a relatively thin package. In testing packages of greater volume the compartment formed by a lower member 21*a* and a substantially similar member 22 may be provided with an insert member 41 defining a package containing space 42 for the package P2. Different types of inserts 41 may be located within the member 21*a* in order to accommodate packets P2 of differing shapes, but the principle methods for determining the "leaker" condition or satisfactory condition of the package P2 will be as previously described.

It is thought that the present invention provides a novel convenient and simple method for the testing of "leakers" in foodstuffs packed in thermo-plastics material after air has been evacuated from to form a continuous process testing mechanism between the packaging of the foodstuffs within the thermo-plastics material and the packaging of such packages into boxes for transportation also and distribution.

CLAIMS

1. A method of testing for a package which has been sealed at a reduced pressure which comprises placing the package within a chamber, reducing the pressure within said chamber and determining the volumetric expansion of the package.

2. A method according to Claim 1, in which the pressure within the chamber is reduced to a predetermined value and the maximum volumetric expansion of the package is determined.

3. A method according to Claim 1, in which the pressure within the chamber is reduced, firstly, to determine the maximum volumetric expansion of the package and then the pressure within the

chamber is increased to a predetermined value at which pressure the volumetric expansion of the package is determined.

4. A method according to any of preceding claims, in which the volumetric expansion of the package is determined by the package contacting a sensor.

5. A method according to Claim 4, in which the sensor is a plunger, which on movement by contact from the package, operates a micro-switch to give an indication thereof.

6. A method according to Claim 4, in which the sensor is an electrical condenser.

7. A method according to Claim 6, in which the condenser consists of a plurality of substantially parallel electrically conducting members such that when the surface of the package contacts said members the capacitance between adjacent electrically conducting members is increased.

8. A method according to Claim 6, in which the condenser consists of a fixed electrode and a pair of hinged electrodes, which are contacted by the package as it expands and are hinged towards the fixed electrode thus, reducing the capacitance between the fixed electrode and the hinged electrodes.

9. A method according to any of the preceding claims, in which the temperature, at which the testing takes place, is determined.

10. A method according to any of the preceding claims, in which an insert member is located within the chamber to provide a volume suitable for the package to be tested.

11. A method of testing a package according to any of the preceding claims, which comprises subjecting the package to a bending moment, to determine the extent to which the package can bend, when a predetermined force is applied thereto.

12. A method of determining if a hermetically sealed vacuum packed package is correctly sealed substantially as described and illustrated with reference to the accompanying drawings.

13. A hermetically sealed vacuum packed package when tested according to any of the preceding claims.

14. Apparatus for testing a vacuum packed hermetically sealed package to ascertain if the package is satisfactorily sealed, comprising a chamber in which a package may be placed, means for reducing the pressure within the said chamber and means for determining the volumetric expansion of the package consequent upon the reduction of pressure within the chamber.

15. Apparatus according to Claim 14, which comprises, a vacuum pump and valve, connected to the interior of the chamber.

16. Apparatus according to Claim 14 or 15, in which the means for determining the volumetric expansion of the package within the chamber comprise a sensor in the form of a plunger which is contacted by the expanding package, which plunger in turn contacts a micro-switch.

17. Apparatus according to Claim 14 or 15, which comprises, a condenser, whose capacitance is increased consequent upon the expansion of the package within the chamber.

18. Apparatus according to Claim 17, in which the condenser consists of a plurality of electrically conducting members, alternatively electrically connected one to another, forming a plurality of parallel condenser electrodes, such that on contact of one or more of the electrodes, by the expanding package, the capacitance between the adjacent electrodes is increased.

19. Apparatus according to Claim 17, in which the condenser consists of a fixed plate and a pair of hinged plates, movable toward said fixed plate, said fixed plate being moved towards the fixed plate consequent upon the expansion of the package.

20. Apparatus according to any of the Claims 14 to 19, having a sensor for determining the temperature within the chamber.

21. Apparatus according to any of the Claims 14 to 20, in which the chamber is provided with an insert member, suitably shaped to fit within the chamber and having a recess formed therein to accommodate a package of predetermined size.

22. Apparatus for testing a vacuum packed hermetically sealed package, substantially as described and illustrated herein with reference to the accompanying drawings.

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